# Effect of the space between twin tunnel faces on the surface settlement

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## ABSTRACT

A series of three-dimensional finite distinct element analyses was carried out for line 1 of Tabriz metro to investigate the interaction between circular parallel twin tunnels constructed with Earth Pressure Balance machine in soft ground. Special attention was paid to the influence of distance between the twin tunnel excavated faces on the surface settlement. It was found that the location of the maximum settlement is offset from the centerline of the first tunnel and the offset increases with increasing space of tunnel faces. Also moment and axial forces of first tunnel decreased by increasing space of tunnel faces.

Keywords: settlement, earth pressure balance, twin tunnels.

## INTRODUCTION

The development of large cities requires the use the underground areas for transportation infrastructures and facilities. In some cities, the geotechnical and underground conditions impose the construction of new tunnels close to existing ones. In other cases, the solution of twin tunnels presents major advantages, such as reduction of both tunnels diameter and soil movement resulting from the tunnel construction (Chen, Lee and Gui, 2009).

Both numerical modeling and in situ observations were used to analyze the interaction between twin tunnels. Results show that in some configurations, the interaction could largely affect the soil settlement and that the design of twin tunnels requires numerical analysis associated to monitoring during the design phase (Hage chehade and Shahrour, 2008).

this paper presents analysis of the interaction between twin tunnels with a particular interest for the distance between tunnel faces. For this concern, numerical analysis was conducted for the investigation of the influence of face spacing on the surface settlement and internal forces resulting from the tunnel construction..

## EXCAVATION BY EARTH PRESSURE BALANCE MACHINE

Tunnel excavation using EPB is based on the principle of face support using the same excavated material, going in the excavation chamber, and putting it under pressure, through the balance between the material entering and the material exiting and with the added machine thrust. The face pressure is controlled by balancing the rate of advance of the shield (proportional to the excavated quantity) and the rate of discharge of the excavated material proportional to the screw conveyor rotation speed. The equilibrium condition occurs when the muck in the excavation chamber reaches the maximum possible density for applying an active pressure to the face and the volume of the muck extracted by the screw conveyor equals the theoretical volume removed by the cutterhead (Guglielmetti, Piergiorgio and et al, 2007). For tunneling using a closed face machine, the application of a face support pressure equal to horizontal stress in ground is often considered to be optimum from the viewpoint of minimizing face deformation and keeping the face stable (Kanayasu, Kubota and Shikibu, 1995). Therefore in this paper, face pressure equal to horizontal stress in ground is applied to the tunnel face.

During mechanized tunneling with a shield machine, the lining segments are erected under the protection of the tail skin. The segmental lining serves as an abutment for the thrust cylinders as well as a support for the excavated cross section (Wittke, Druffel and et al, 2007). After installation of the segments, the annular gap between the segmental lining and excavation contour is grouted for mortar to keep the bending moment and the deformation of the lining small by